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spotted moray. Perhaps the most interesting things which came from the surface of the banks were a number of calcareous spheres three or four inches in diameter. They were composed of thin concentric layers and were apparently of organic origin. Further than this no explanation of their origin was forthcoming.

Alfred Russel Wallace has pointed out how typical the Bermudan terrestrial fauna is of an oceanic island. Only three indigenous vertebrates are present otherwise than birds. It is significant that the only mammal is winged, a bat. He expresses surprise at the small number of insects described. Since the publication of his book the list has been swelled to over three hundred. That a considerable proportion are not indigenous is evident from the fact that twenty species were found en route for Bermuda on one ship sailing from New York. The gulf stream flowing within one hundred miles to the west of Bermuda, the drift of the surface water from the south and west, and the West India hurricanes were no doubt the important agents in bringing animal life from the North American continent.

J. E. KIRKWOOD,

Corresponding Secretary.

THE ELISHA MITCHELL SCIENTIFIC SOCIETY OF
THE UNIVERSITY OF NORTH CAROLINA.

THE 159th meeting of the society was held in the chemical lecture room, Tuesday, 7:30 P.M., March 14, 1905. The following papers were presented:

PROFESSOR A. S. WHEELER: 'Normal Paper.'

PROFESSOR W. C. COKER: 'The Mutation Theory.'

PROFESSOR J. E. MILLS: 'Chemical Affinity: A Method for Distinguishing Chemical Energy from Simultaneous Physical Energy Changes.'

ALVIN S. WHEELER,

DISCUSSION AND CORRESPONDENCE.

NATURAL MOUNDS.

IN Dr. Brauner's interesting article on 'Natural Mounds' in *SCIENCE* for March 31, he mentions the fact, in connection with the distribution of these mounds in the Mississippi Valley, that they follow up the valley of the Arkansas and of the Neosho rivers across

Indian Territory into southeastern Kansas. These mounds are exceedingly abundant in southwest Missouri also. They are a characteristic feature of the landscape in Lawrence County, Mo. (second tier of counties from Kansas and from Arkansas), where the writer lived for many years. They are abundant both in the timber and on the prairies, but are more noticeable on the prairies because of the fact that on them the prairie grasses give place to taller forms of vegetation. Before the lands were put in cultivation these mounds were from one to three feet high, and usually twenty to thirty feet in diameter. On newly reclaimed land crops grow much more luxuriantly on the mounds than elsewhere. Corn is usually the first crop planted on new lands in that section, and it is usual for corn on mounds to grow nearly twice as tall as on surrounding areas the first year. This difference in growth gradually disappears as cultivation continues.

These mounds have probably originated from different causes in different regions. In southwest Missouri their origin is probably due to the following cause: The soil of the region has been formed from the decay of the great sub-carboniferous limestones. Where these strata are exposed in cliffs there may occasionally be found concretions of flint several feet in diameter. The flint is broken into rather small fragments, which fall apart more or less when the surrounding limestone disintegrates into soil. The flint resists disintegration far greater than the limestone. These masses of flint fragments later become prominent as mounds by the more rapid denudation of the surrounding soil containing comparatively little flint. This theory is strengthened by the fact that the material forming the mounds to a depth of several feet consists very largely of small flint stones.

W. J. SPILLMAN.

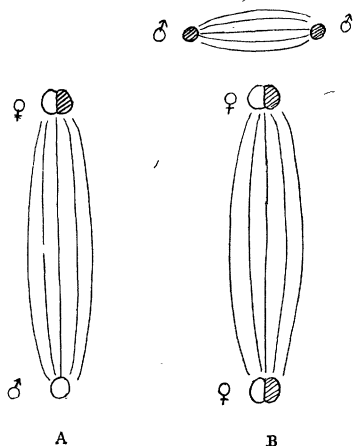
U. S. DEPARTMENT OF AGRICULTURE.

SPECIAL ARTICLES.

AN ALTERNATIVE INTERPRETATION OF THE ORIGIN
OF GYNANDROMORPHOUS INSECTS.

THE occasional occurrence in the groups of ants, bees, wasps and butterflies of individuals

that show male characters in certain parts of the body and female characters in other parts—the so-called gynandromorph condition—has long been known, and several suggestions have been made to account for the result. The view recently proposed by Boveri has met



with the most favor. Before stating this view it may be well to recall that in bees it is generally admitted that unfertilized eggs give rise to male individuals (drones) *as a rule*, while fertilized eggs give rise to females (queens or workers). Boveri has suggested that the gynandrous condition may be due to the spermatozoon failing to unite with the egg nucleus, but subsequently pairing with one of the products of its first division, as shown in diagram A. If a union of this sort should occur, all of the cells that are derived from the paired nucleus might be expected to give rise to female characters (as in the case of the *fertilized egg*); while all the cells that come from the unpaired half of the nucleus might be expected to produce male parts. Hence the individual that develops from such an egg might be expected to show the characters of the two sexes combined in different ways according to the positions of the descendants of the two kinds of cells. On purely theoretical grounds I offer an alternate hypothesis which will explain the facts equally well. Moreover, if this view, rather than Boveri's, should prove to be the correct one it will furnish important data in regard to the value of the

spermatozoon in determining the sex of the bee. I venture to suggest this alternation, especially, as the two views can be put to the test of actual observation by any one in position to obtain the necessary material; and also because the possibility of this interpretation appears to have been entirely overlooked as an explanation of gynandromorphism. I suggest in brief that the results may be due to two (or more) spermatozoa entering the same egg, one only fusing with the egg nucleus, and the other not uniting, but developing without combining with any parts of the egg nucleus, as shown in diagram B. The products of division of the paired nucleus will account for the female parts of the embryo, while the products of the division of the single sperm nucleus will account for the male characters of the other parts. The assumption of polyspermy on my view is not arbitrary, for it has been often described for the bee and other insects, and seems to be of frequent occurrence. As a rule it appears that the spermatozoa that do not unite with the egg nucleus fail to develop, but under exceptional cases they may do so. In fact, several cases of 'male parthenogenesis' in other forms have been described in recent years.

It will be observed that on Boveri's hypothesis the male characters will be derived from the egg nucleus, while on my view they will come from the unpaired sperm nucleus. If, therefore, a queen of one race and a drone of another should produce one of these gynandromorphs we ought to be able to decide which of these views is correct; for, on Boveri's hypothesis, the male characters of the gynandromorph would be those of the race to which the mother belongs, while on my view they would be those characteristic of the race of the father. Thus if an Italian queen-bee were to be fertilized by a German drone and a gynandromorph produced, the male parts should be Italian on Boveri's view, and German on mine.*

* I am aware, of course, of the prolonged discussion that has taken place in regard to the character of hybrid bees, but despite these difficulties the test might still be made, especially as the drones are generally described as purely paternal.

Von Siebold had in fact a case of this sort in the famous Eugster hive from which he obtained his material. Unfortunately his statement in regard to the racial characters of the gynandromorphs is obscure. The following quotation is the only reference that he has made to the racial characters of these bees.

Die fünf Jahre Königen dieses Stockes war eine reine Italienerin und hatte nichts Auffallendes an sich. Sie musste sich mit einer deutschen Drone begattet haben, da sich ausser reinen italienischen Arbeitern auch noch viele Bastardarbeiter von verschiedener Abstufungen in demselben Stocke befanden, während die Drohnen dieses Stockes ihre reine italienischen Abkunft verriethen. Auch die Zwitterbienen [gynandromorphs] dieses Stockes besaßen die Färbung der italienischen Race; doch war dieselbe unter dem Einflusse der deutschen Race hier und dort getrübt worden.

In addition to the interest of determining which of these alternative views is the true explanation, there is, as I have pointed out, an implication in my hypothesis of more general importance. On my view the sperm-nucleus alone produces male characters, just as the egg nucleus alone produces male characters. If established, therefore, my view would show that in the bee the male and the female nuclei are exactly equivalent as sex determinants. Alone, either produces male characters, united in the same nucleus, they give rise as a rule to female characters. The results appear, therefore, to be quantitative and not qualitative. From this point of view the male nucleus is not the bearer of the female sex-characters (although both sexual characters may be latent in each nucleus), but combined the two nuclei give the characters of the female.

It is far from my intention to set one of these hypotheses over against the other, and to attempt to weigh their relative merits on the grounds of probability. I have raised the question not to invite discussion, but to appeal to those who may have an opportunity to examine gynandromorphs from mixed hives. Neither do I wish to appear to be propounding a theory of sex-determination, that will apply to other cases in which other factors than

fertilization appear to determine the sex of the individual.

In the group of Lepidoptera it may seem at first sight that neither Boveri's view nor my own can explain the occurrence of gynandromorphs, because it is not the rule here that unfertilized eggs produce males, although this sometimes occurs. The discrepancy is more apparent than real, for, even if female butterflies develop from parthenogenetic eggs, as a rule, the same explanation used for the bees can *mutatis mutandis* be applied. If, for example, the egg nucleus alone, or the sperm nucleus alone, produces female characters then on Boveri's view when the sperm nucleus unites with one of the products of the first division of the egg nucleus the resulting cells may also happen in some cases to produce male characters (just as some of the fertilized eggs become males). The other half of the first division produces a female, on the theory, and a gynandromorph results. Under such circumstances the female side of the individual would show the character of the race to which the mother belonged, if a hybrid gynandromorph should be produced. If on the above assumption the united male and half female nuclei should produce a female instead of a male then both sides would be female, and there would be nothing externally to indicate that such an individual was different from an ordinary female. On my view also a formal explanation can be offered for the lepidopterous gynandromorphs. If the united nuclei should happen to produce male, and the single sperm nucleus should give rise to female characters a gynandromorph would result. In a hybrid of this kind of individual the female characters would be paternal. If the united nuclei happen to produce a female (since fertilized eggs may produce either males or females), and the sperm nucleus also produces a female, then both sides will be superficially alike, and nothing would indicate that such a female individual had had an abnormal origin.*

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* If male-determining and female-determining spermatozoa exist the gynandromorphous condition in the bee might also be accounted for on the